

A revision of the *Leucochrysum albicans* (Asteraceae: Gnaphalieae) complex

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Abstract

A morphometric study of the *Leucochrysum albicans* (DC.) Paul G.Wilson complex (*L. albicans*, *L. graminifolium* (Paul G.Wilson) Paul G.Wilson and *L. molle* (DC.) Paul G.Wilson), concluded that five taxa be recognized from the current six. *L. albicans* subsp. *alpinum* (F.Muell.) Paul G.Wilson is elevated to specific rank as *L. alpinum* (F.Muell.) R.J.Dennis & N.G.Walsh and *L. albicans* var. *buffaloensis* (Paul G.Wilson) Paul G.Wilson is reduced to synonymy under the typical variety. Other members of the complex are maintained at their current ranks.

Keywords: species complex, morphometric analysis, scanning electron microscopy

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Introduction

The *Leucochrysum albicans* complex comprises a group of closely related taxa that have caused taxonomic confusion in the past; e.g. "Variation between the taxa within *Helipterum albicans* [now *Leucochrysum* spp.] appears ... to be continuous ... each taxon intergrades with one or more of the other taxa" (Wilson, 1960, pp. 163, 164). The *L. albicans* complex is here regarded as consisting of *Leucochrysum albicans*, *L. molle*, and *L. graminifolium*. The two remaining members of the genus, *L. fitzibbonii* (F.Muell.) Paul G.Wilson and *L. stipitatum* (F.Muell.) Paul G.Wilson, are morphologically distinct from the *L. albicans* complex and both have a Central Australian distribution (Wilson 1992). They were not included in this study.

Leucochrysum molle has a wide distribution including central and eastern South Australia, southern Queensland, western New South Wales, and northern Victoria (Fig. 10). *L. molle* has linear to broadly obovate, lightly cobwebbed leaves and triangular, ovate to suborbicular yellow involucre bracts. It is an annual whereas other members of the genus are perennials (Wilson 1960). Occurring in sandstone outcrops of the central tablelands in New South Wales, *L. graminifolium* has a woody stem, usually retaining remnants of previous years' growth. The linear to filiform leaves are light green, the dorsal surface glabrescent while the ventral side remains covered in a cobwebbed mat of hair and the margins are tightly revolute. The involucre bracts are narrow to ovate (Harden 1992). *Leucochrysum albicans* sens. lat. (sensu Wilson 1992) extends from south eastern Queensland, through eastern New South Wales, the Australian Capital Territory, much of Victoria and into Tasmania.

Leucochrysum albicans sensu Wilson (1992) has two subspecies; *albicans*, and *alpinum*, the latter occurring only in the alpine regions of Victoria and New South Wales. Wilson (1992) noted that *L. albicans* subsp. *alpinum* differs from subsp. *albicans* by having obovate to oblanceolate, densely lanuginose, flat leaves with slightly incurved margins. The inner involucre bracts are always white and the outer involucre bracts brown to purple, and elliptic to ovate.

Leucochrysum albicans subsp. *albicans* has linear to oblanceolate, cottony leaves with recurved to tightly revolute margins. It currently includes three varieties: the typical variety, var. *buffaloensis* (Paul G. Wilson) Paul G. Wilson and var. *tricolor* (DC.) Paul G. Wilson. The typical variety is widespread throughout the range of the species excluding Tasmania and higher alpine areas. *Leucochrysum albicans* var. *buffaloensis* is restricted to Mt Buffalo and immediate environs, Victoria, and var. *tricolor* has three pockets of distribution, south-eastern New South Wales to north-eastern Victoria, south-western Victoria and scattered sites in Tasmania.

Within *L. albicans* subsp. *albicans*, var. *tricolor* is typically distinguished by the white inner involucre bracts and deep red to purple outer involucre bracts whereas vars *albicans* and *buffaloensis* both have yellow inner involucre bracts and brown outer involucre bracts. Var. *buffaloensis* is distinguished by having acutely tipped, broadly ovate to deltoid involucre bracts whereas var. *albicans* has elliptic to ovate involucre bracts with obtuse apices.

Some of these taxa seem trivially distinguished (Wilson 1960; Short 1999) with some herbarium material being tentatively placed, while subsp. *alpinum* appears to be consistently distinct. In an attempt to resolve the uncertainty apparent within the *L. albicans* complex, a study was undertaken to test the current classification using numerically-based morphometric techniques.

While carrying out this study variation was found in the leaf hairs amongst the different taxa. More detailed study aimed to examine the "stalked glandular hairs" of *L. albicans* and *L. molle* referred to by Short (1999) for any consistent patterns of variation that might support a revised taxonomy. Previous studies of micromorphological characters have found that shape and cell structure of mature carpodia can be used to delineate taxa (e.g. Sundberg 1985) and these were examined for members of the complex. Scanning electron microscope studies were also undertaken to see if characters of the cypsela pericarp were informative.

Materials and methods

Character list and analysis

An initial scoring of 72 specimens using 60 morphological and longevity characters, including those mentioned in

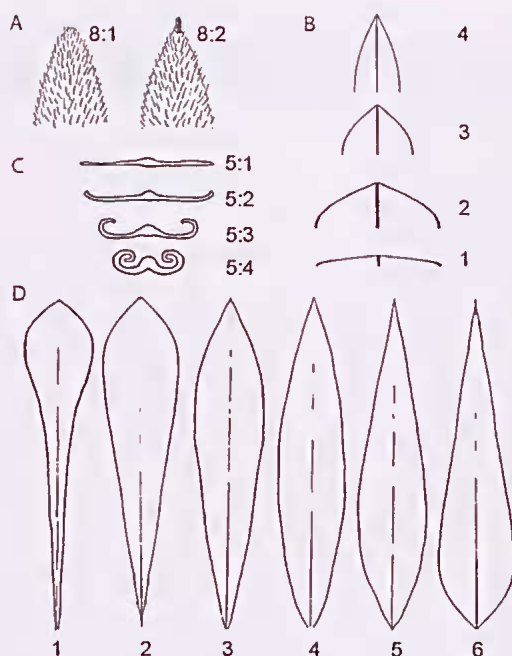


Figure 1: Schematic drawings of (a) leaf tip, showing the two states of character 8; (b) involucre bract lamina tip, showing the range in angles of both characters 12 and 13; (c) leaf margin, showing the range of curvature in character 5; (d) leaf and involucre bract shape, based on position of widest point along the length of the blade. Characters are numbered as in Table 1.

previous taxonomic treatments (e.g. Wilson 1960, 1992; Harden 1992, Short 1999), was carried out and subjected to analysis using the PATN program package (Belbin 2004). From this analysis, 14 characters were found to be informative and these were used to score 118 herbarium specimens. Previously published references have not separated leaf or involucre bract shape into their component attributes or made reference to other characters found to be informative during this study (Fig. 1; Table 1). These new characters combined with traditional diagnostic characters were used to carry out a morphometric analysis of the members of the *L. albicans* complex.

The 118 specimens examined in the analysis were sourced from the National Herbarium of Victoria (MEL), and the National Herbarium of New South Wales (NSW). Specimens from the herbarium of the Australian Daisy Study Group and collections made in the course of the study by a colleague, K. McDougall, have since

Table 1. Characters for morphometric study.

#	Character	#	Character
1	Life 1. annual 2. perennial	8	Leaf Tip 1. tip of leaf covered in hair 2. dark bald, mucronate tip
2	Leaf shape 1. spatulate 2. obovate 3. obovate / elliptic 4. elliptic 5. elliptic / ovate 6. ovate	9	Length of the lamina of the longest involucre bract (mm)
3	Width of widest part of longest leaf (mm)	10	Involucre bract ratio, length (mm) / width (mm)
4	Leaf ratio leaf length (cm) / leaf width (mm)	11	Involucre base shape 1. spatulate 2. obovate 3. obovate / elliptic 4. elliptic 5. elliptic / ovate 6. ovate
5	Leaf margin 1. flat 2. curved slightly inwards 3. recurved 4. revolute	12	Angle at tip of involucre bract lamina 1. flat to round 2. obtuse 3. 90° 4. acute
6	Leaf hair density 1. 0 - 10% (glabrescent - sparse) 2. 11 - 30% (light cobweb) 3. 31 - 60% (cobweb) 4. 61+% (woolly)	13	Angle at base of involucre bract lamina 1. flat to round 2. obtuse 3. 90° 4. acute
7	Leaf hair distribution 1. even hair density across dorsal and ventral surfaces 2. less hair on dorsal surface compared to ventral surface	14	Involucre bract colour 1. yellow 2. yellow and white 3. white

been incorporated into MEL's collections. The data were then analysed using PATN. The association matrix utilised the Gower metric. An ordination was produced using Semi-strong Hybrid Multidimensional Scaling (limit= 0.9) with two dimensions and a dendrogram was generated utilising flexible UPGMA ($\beta=0.1$). Evaluation of characters was carried out using Principal Component Correlation (PCC) which generates the value and direction each character has on the points in ordination space (Belbin 2004).

Seedling germination

Plants were grown from seed at the nursery of the Royal Botanic Gardens Melbourne (RBGM). Diagnostic characters seen in the herbarium specimens were compared to seedlings as they were grown in the controlled environment of a glass house.

SEM preparation

Leaf samples were taken from the nursery-grown plants. Plants used were grown for eight weeks. Leaf samples were placed in 70% ethanol upon collection.

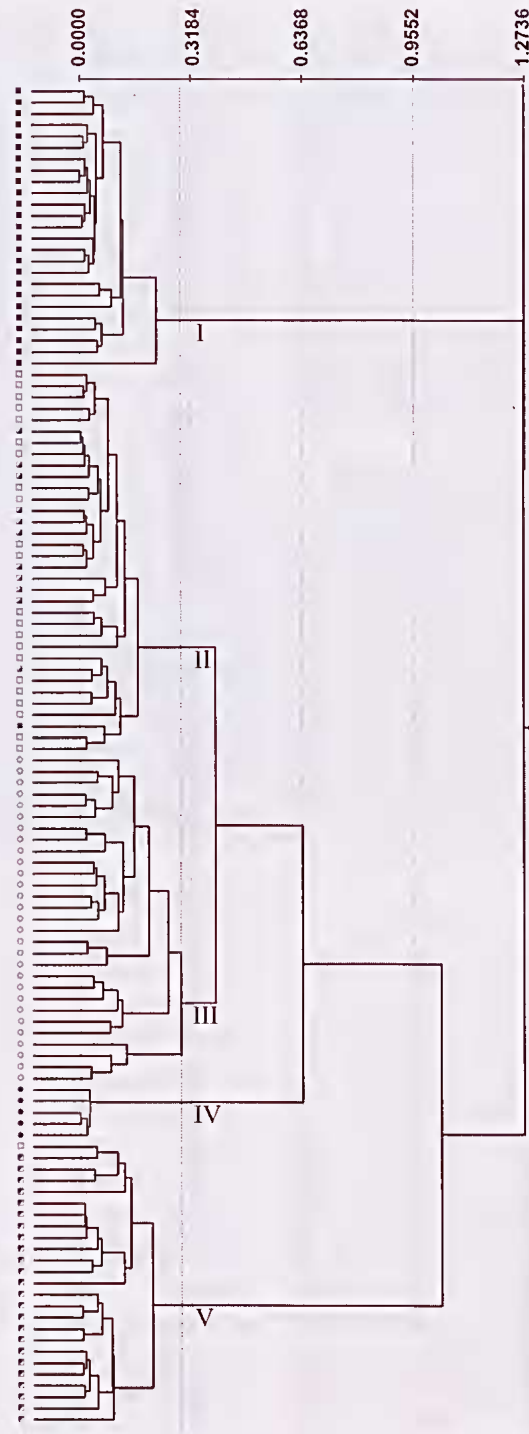


Figure 2: Cluster dendrogram of 118 specimens originally determined as *L. albicans*, *L. malle* and *L. graminifolium*. The 14 characters listed in Table 1 were analysed by Gower metric association with a flexible UPGMA ($\beta = -0.1$). At dissimilarity of 0.29 five groups are recognised I-V. Original determinations shown by symbols on left of dendrogram: *L. albicans* subsp. *alpinum* – solid squares; *L. albicans* var. *albicans* – open squares; *L. albicans* var. *buffalaensis* – squares, black in the lower right triangle; *L. albicans* var. *tricalar* – open circles; *L. graminifolium* – solid circles; *L. malle* – squares, black in the top left triangle.

Samples were then treated for 75 min in 90% ethanol then transferred to 100% ethanol and gently agitated for 24 hrs. Samples were then placed in fresh 100% ethanol and agitated for another 24 hrs. Critical Point Drying (CPD) of specimens was carried out the following day following the technique of Boyde and Wood (1969). Leaf tissue taken from the centre of the treated leaves was then placed on SEM stubs exposing both dorsal and ventral surfaces, then coated with gold using a Dynavac 'Xenosput' magnetron sputter coater. A Phillips XL 30 FEG Field Emission Scanning Electron microscope was used to examine the surfaces and capture the images.

From each of the taxa, two to three whole fruits, one with carpopodium exposed were placed on SEM stubs, desiccated, and sputter-coated with gold as described above.

Distribution maps

Distribution data were collated from AD, BRI, CANB, HO, MEL and NSW. Points with a geocode precision of less than 25 km were excluded.

Results

Dendrogram

The composition of the groups largely corresponds with current classification with five groups retrieved above a dissimilarity level of 0.29 (Fig. 2) with Group I comprising *L. albicans* subsp. *alpinum*; Group II, *L. albicans* var. *albicans*; Group III, *L. albicans* var. *tricolor*; Group IV, *L. graminifolium*; and Group V, *L. molle*. PATN could not distinguish *L. albicans* var. *buffaloensis* from var. *albicans*. The dendrogram pairs those specimens most similar to each other first and then progressively unites the groups. The less similar the specimens or groups are the later they will fuse. The first fusion is between Groups II and III, and then Groups IV, V and I successively join the cluster comprised of the other specimens.

Two specimens are apparently misplaced (based on the original determinations). One of these (*Adair s.n.*) originally held at MEL under *L. albicans* subsp. *alpinum* but classified by PATN with Group II (subsp. *albicans*) is a curious specimen, with the white and mauve involucre bracts of subsp. *alpinum* but with leaves narrower than normal and with a glabrous callous tip

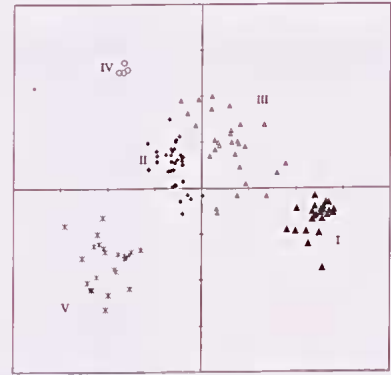


Figure 3: Ordination of 118 specimens originally determined as *L. albicans*, *L. molle* and *L. graminifolium*, using Semi-strong Hybrid Multidimensional Scaling and a Gower metric association matrix for the 14 characters in Table 1.

Groups as in Fig. 2.

more characteristic of subsp. *albicans*. It may represent a hybrid between the two taxa, both being in the general area. If so, it is the only hybrid we encountered during the study. The apparently misplaced specimen in Group V (*L. molle*) was simply a misdetermination and this has now been rectified (*Short 3618*).

Ordination

In the ordination the stress was 0.0809, indicating a good fit between the two dimensional representation and the original data matrix. In the ordination space, more similar individuals are placed closer together. The same five groups as identified in the dendrogram (Fig. 2) remain resolved in the ordination (Fig. 3). Groups I (*L. albicans* subsp. *alpinum*), IV (*L. graminifolium*) and V (*L. molle*) are all well separated, while Groups II and III (*L. albicans* vars *tricolor* and *albicans* respectively) are closely contiguous but discrete. However, when character 14 (bract colour) was excluded from the analysis, groups III and II merged (not illustrated here). This indicates the closeness of these taxa and supports the retention of the bract colour that has traditionally been used to distinguish these two taxa. The composition of the groups is consistent with previously described taxa except in relation to var. *buffaloensis*. As with the dendrogram, there was no evidence of a discrete group for specimens that had been determined as var. *buffaloensis* and Group III

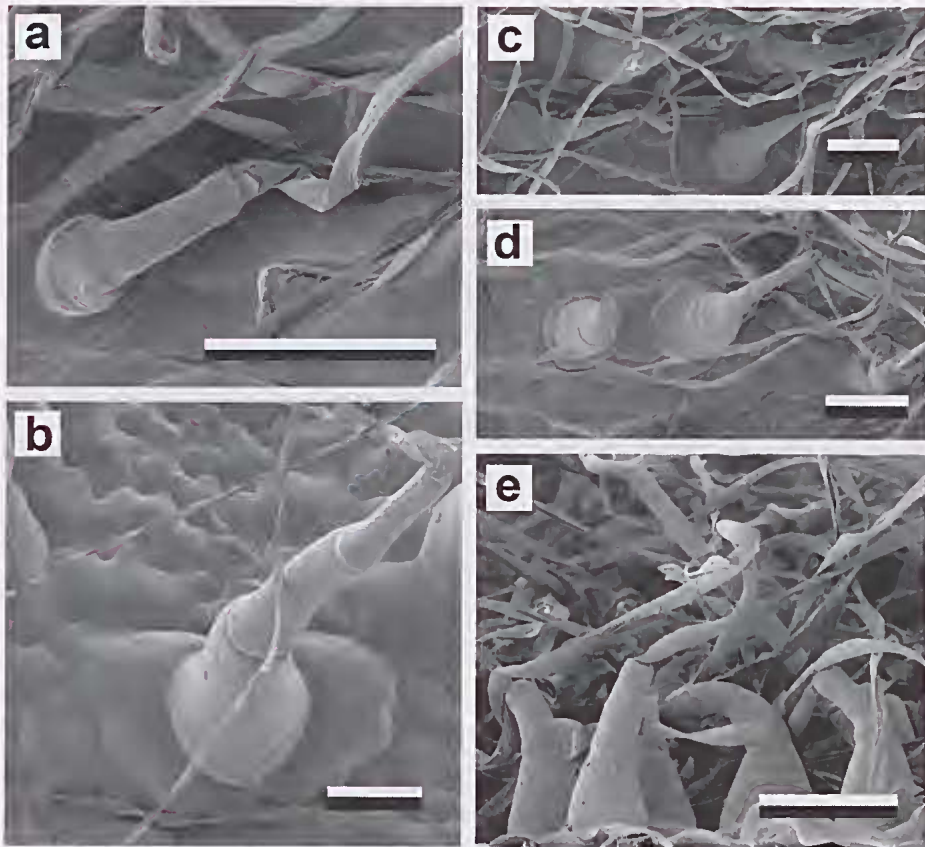


Figure 4: SEM images of the leaf hairs of the dorsal surface of leaves from (a) *L. albicans* subsp. *albicans* var. *tricolor*; (b) *L. malle*; (c) *L. albicans* subsp. *alpinum*; (d) *L. albicans* subsp. *albicans* var. *albicans*; (e) *L. albicans* subsp. *albicans* var. *buffaloensis*. The scale bars are 50 μ m.

was a mixture of specimens determined as either var. *albicans* or *buffaloensis*.

Seedling characters

The early-adult leaves of the nursery-raised seedlings generally maintain the diagnostic features apparent on herbarium specimens. However the margins of leaves of all taxa were less strongly recurved than those of herbarium specimens, possibly a consequence of the more humid growing conditions in the nursery.

Leucochrysum molle had leaves with strikingly less dense indumentum, broader than those of var. *albicans* and much broader those of var. *tricolor*. The margins of the leaves of *L. molle* were also less recurved than those of *L. albicans* vars *tricolor* and *albicans*. Leaves of subsp. *alpinum* were densely covered in hair, had a distinctly spathulate shape, little to no recurving of the margin and

lacked an obvious glabrous mucronate tip. All the other taxa grown have glabrous mucronate tips. There was little difference between vars *buffaloensis* and *albicans*, the former tending to have slightly broader leaves.

Eglandular leaf hairs

The leaf hairs of the taxa examined consist of inflated epidermal cells subtending one to five (usually three) stout basal cells above which is a filamentous ribbon-like extension composed of a number of elongated collapsed cells (Fig. 4). These hairs are found on all taxa examined. They belong to 'hair type B' sensu Drury & Watson (1966) and are common amongst members of the Asteraceae (Bessey, 1889; Bremer, 1994). *Leucochrysum molle* (Fig. 5b) has the largest hair basal cells of any of the taxa studied. They are at least three times larger than *L. albicans* var. *tricolor* (Fig. 5a). The

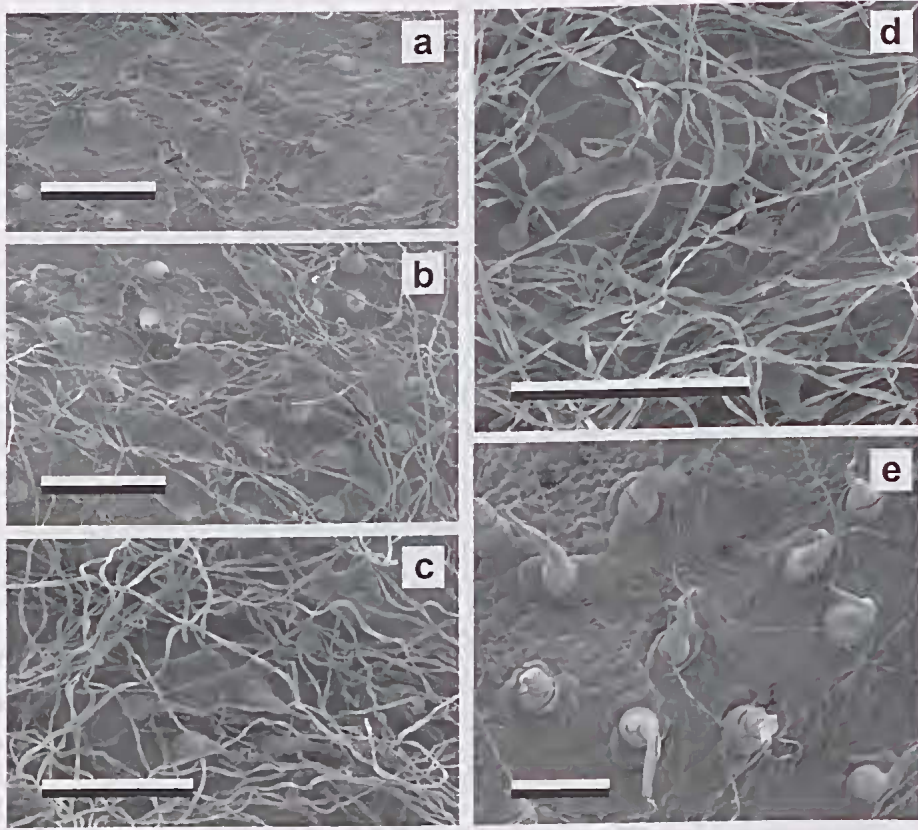


Figure 5: SEM images of the leaf hairs of the dorsal surface of leaves from (a) *L. albicans* subsp. *albicans* var. *albicans*; (b); *L. albicans* subsp. *albicans* var. *tricolor* (c) *L. albicans* subsp. *alpinum*; (d) *L. albicans* subsp. *albicans* var. *buffaloensis*; (e) *L. malle*. The scale bars are 200 μ m.

size of the hair basal cells is proportional to the size of the epidermal cells in all the taxa.

The density of hairs differs between the taxa, ranging from the sparsely covered *L. molle* (Fig. 5e) to the densely lanuginose surface of *L. albicans* subsp. *alpinum* (Fig. 5c). The hairs of vars *albicans* (Fig. 6a), *tricolor* (Fig. 6b) and *buffaloensis* (Fig. 6d) are all similarly cottony in contrast. The hairs of the ventral surfaces have longer and thinner basal cells (Fig. 6) than those of the dorsal surfaces (Fig. 4). This difference is consistent across all taxa. The collapsed cells forming the tapering part of subsp. *alpinum* are more twisted than those of the other taxa (Fig. 5).

Glandular leaf hairs

The glandular hairs consist of four rows of paired cells (Fig. 7). The apical secretory pair of cells are larger

than the supporting cells. These hairs are present on all the taxa examined. The general morphology of the glandular hairs is typical of many members of the Asteraceae (Hess 1938). Their distribution is sparse but consistent across the surface of the leaves (Fig. 6)

Pericarp surface

Although there is significant variation in the surface texture of the cypselas examined, both light and scanning electron microscopy has shown these to be of little taxonomic value within the complex. Surface textures examined ranged from smooth to distinctly colliculate, even within a taxon. A selection of SEM images indicating the range of surface textures of the *L. albicans* complex are presented in Figure 8, however, as stated, despite the substantial variation shown here, variability within taxa was too great for this character to

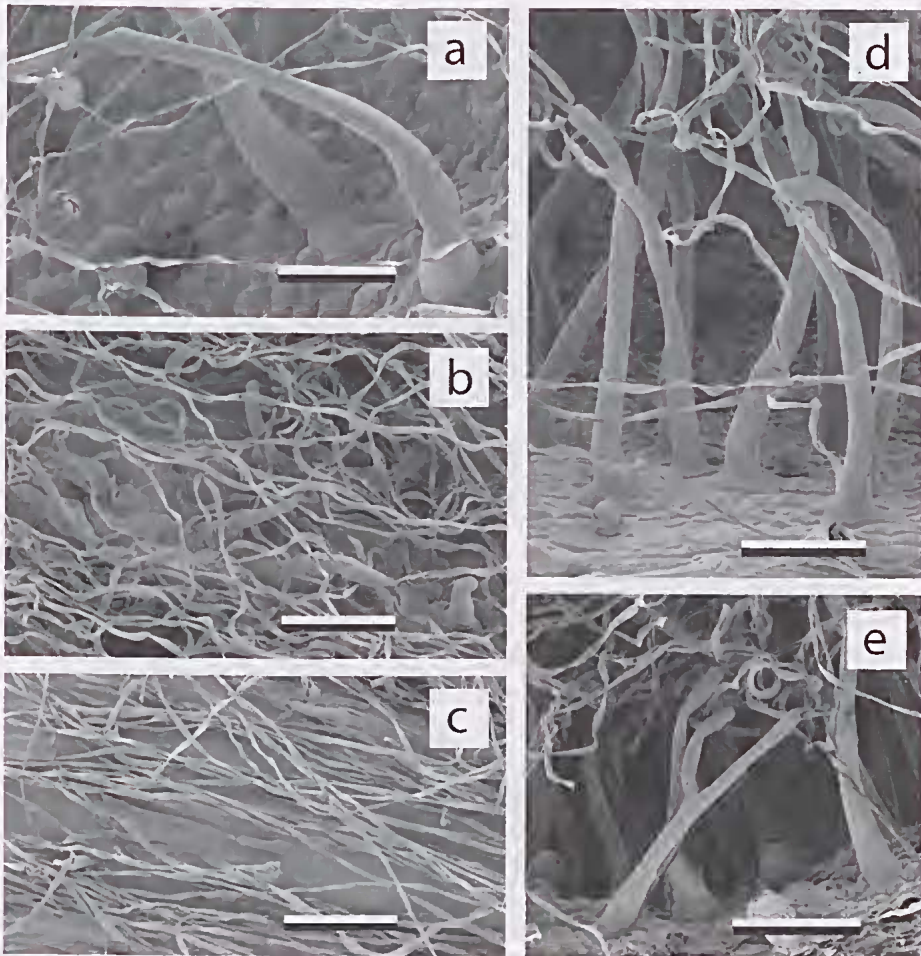


Figure 6: SEM images of the leaf hairs of the ventral surface of leaves from (a) *L. molle*; (b) *L. albicans* subsp. *alpinum*; (c) *L. albicans* subsp. *albicans* var. *tricolor*; (d) *L. albicans* subsp. *albicans* var. *albicans*; (e) *L. albicans* subsp. *albicans* var. *buffaloensis*. The scale bars are 100 μm .

be regarded as useful. The 2-celled myxogenic papillae regarded by Wilson (1992) as being diagnostic of *L. graminifolium* were not observed during this study.

The carpodium

Scanning electron micrographs are presented of the carpodia of members of the *L. albicans* complex. There is a distinct boundary between the carpodium cells and those cells that make up the rest of the pericarp whether the pericarp has a papillose or flat surface (Fig. 9). Despite some variation in outline of the carpodium (due to the position of the cypsela within the capitulum (Sundberg 1985)) the carpodia of the different taxa exhibit basically the same morphology.

The carpodial cells are rectangular to oblong, and between 20 and 60 μm long.

Taxonomy

Morphological analysis, nursery trials and field examination support the reduction in members of the *L. albicans* complex from six to five, reducing *L. albicans* var. *buffaloensis* to synonymy under the typical variety. The recognition of var. *tricolor* is supported, although on the single criterion of the possession of white rather than yellow capitular bracts. The rank of variety is regarded as appropriate. *Leucochrysum albicans* subsp. *alpinum* is retrieved as a strongly supported group in the analysis. Its distinctiveness in the complex is shown



Figure 7: Images of the glandular trichomes on the (a) dorsal surface of a leaf from *L. albicans* subsp. *albicans* var. *buffaloensis* viewed through a light microscope; (b) ventral surface of a leaf from *L. albicans* subsp. *albicans* var. *tricolor* viewed using SEM. Scale bars are 20 µm.

in both the dendrogram and ordination to be as great or greater than either *L. molle* or *L. graminifolium* from 'core' *L. albicans* and it is proposed that it be recognised similarly at species rank.

The following key serves to distinguish the members of the complex.

Taxonomy and ecology

For full synonymy of the following names, see Wilson (1992).

***Leucochrysum albicans* (A.Cunn.) Paul G.Wilson, *Nuytsia* 8:442 (1992)**

Helichrysum albicans A.Cunn. in Field, *Geog. Mem. New South Wales* 359 (1825). *Type:* Forest Land, Cox's River, 9 Oct. 1822, A. Cunningham 71 (lecto: K; isolecto MEL2068831) *fide* Wilson 1960.

Leucochrysum albicans* var. *albicans

Leucochrysum albicans var. *buffaloensis* (Paul G.Wilson) Paul G.Wilson, *Nuytsia* 8:443 (1992); *Helipterum albicans* var. *buffaloensis* Paul G.Wilson, *Trans. Roy. Soc. South Australia* 83:170 (1960). *Type:* Mt Buffalo, Victoria,

Key to taxa

- 1 Leaves spatulate to broadly obovate, densely woolly; margin flat; apex lacking an obvious mucro or callus tip. Inner involucre bracts lanceolate to ovate, white, outer involucre bracts purplish to brown (especially apparent in early stages of capitulum development) *L. alpinum*
- 1: Leaves obovate to filiform, cobwebbed to cottony or glabrescent; margin gently recurved to tightly revolute, apex with short glabrous mucro or callus tip. Inner involucre bracts suborbicular to broadly ovate or ovate, lanceolate to elliptic, white or yellow 2.
- 2 Annual herb; leaves lightly cobwebbed, obovate to oblanceolate. Inner involucre bracts suborbicular to broadly ovate, rounded or truncate at base of lamina, yellow *L. molle*
- 2: Perennial (although sometimes short-lived); leaves cottony or glabrescent, obovate to oblanceolate or linear to filiform. Inner involucre bracts obovate to ovate to lanceolate, white or yellow 3
- 3 Leaves filiform, glabrescent; margin tightly revolute. Involucre bracts narrow-elliptic *L. graminifolium*
- 3: Leaves obovate to oblanceolate or linear, cottony; margin recurved to revolute. Inner involucre bracts ovate to lanceolate, white or yellow 4 (*L. albicans*)
- 4 Inner involucre bracts yellow *L. albicans* var. *albicans*
- 4: Inner involucre bracts white *L. albicans* var. *tricolor*

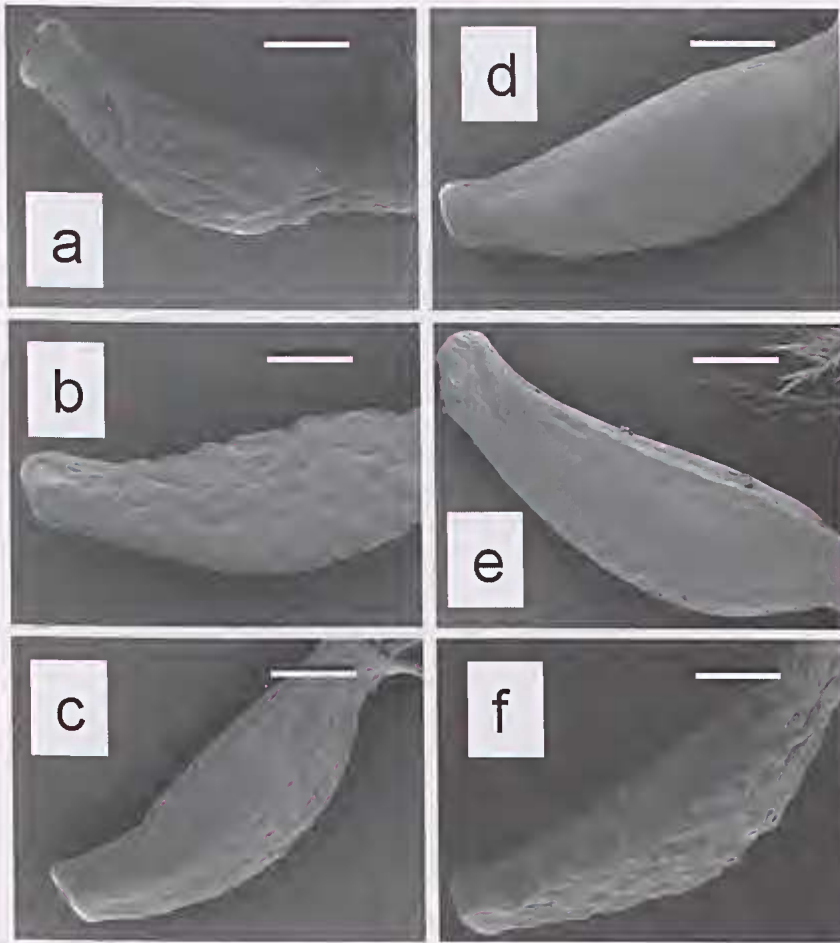


Figure 8: SEM images of cypselas pericarp detail of (a) *L. albicans* subsp. *albicans* var. *tricolor*; (b) *L. malle*; (c) *L. graminifolium*; (d) *L. albicans* subsp. *albicans* var. *buffalaensis*; (e) *L. albicans* subsp. *alpinum*; (f) *L. albicans* subsp. *albicans* var. *albicans*. Scale bars are 500 μm .

10 Nov. 1955, *E. Gauba* (holo: GAU) *vide* Wilson 1992.

Typically associated with dry open forests on shallow, rocky soils derived from a range of parent materials, but frequently sedimentary (mudstones, conglomerates etc.), but also occurring in subalpine heaths and, rarely, lowland grasslands or woodlands. Altitude range c. 100–1800 m. Qld, NSW, ACT, Vic. (Fig. 10a)

Representative specimens (specimens marked with asterisk used for SEM studies): **QUEENSLAND.** Ruby Ck near Stantharpe, 3.x.1992, *E. Salkin* s.n. (MEL2339313). **NEW SOUTH WALES.** Tenterfield, C. Stuart s.n., s.d. (MEL2161748); Near Tenterfield, xi.1874, C. Stuart s.n. (MEL2161778); 25 km S of Tenterfield, 29.ix.1987, *E. Salkin* s.n. (MEL2339315); Maanan Braak, 1883, *S.H. Carter*, s.n. (MEL2161764); Timbarra, C.

Stuart 136 (MEL); Cavan, near Yass, *J.S. Calvert*, s.n., s.d. (MEL); New England, *collector unknown* 30 (MEL); Hastings river, *H. Beckler* s.n., s.d. (MEL); New England, 1886, *R. Callie* s.n. (MEL2161790); **VICTORIA.** Wanga Park, Warrandyte State Park, *D.J. van Bockel* 88 (MEL); Mt Hedrick, *D.E. Albrecht* 1952 (MEL292007); Wabanga Plateau State Park, *A.D.J. Piesse* 393 (MEL685270); Hume Freeway, between Langwaad and Euraa, *R. Thomas* 77 (MEL717321); Mansfield-Langwaad Rd, Euraa district, *R. Thomas* 74 (MEL717324); The Bluff, *D.E. Albrecht* 1555 (MEL1537304); Old Hume Highway, Winton, *J. Strudwick* 676 (MEL); 5 km ENE of Chiltern, *G. Jahnsan* 25 (MEL1589399); 9.7 km W of Whitfield, *H.M. Jalley* 17 (MEL2036568, S); Maunt Buffalo, Bald Hill, 20.ii.1963, *J.H. Willis* s.n. (MEL502500); Wall of China, Mt Buffalo, *R. Melville* 2602 (K, MEL526618); Path to Reeds Laakout, Mt Buffalo, *M.A. Tadd* 250 & 329 (MEL559884, 562279);

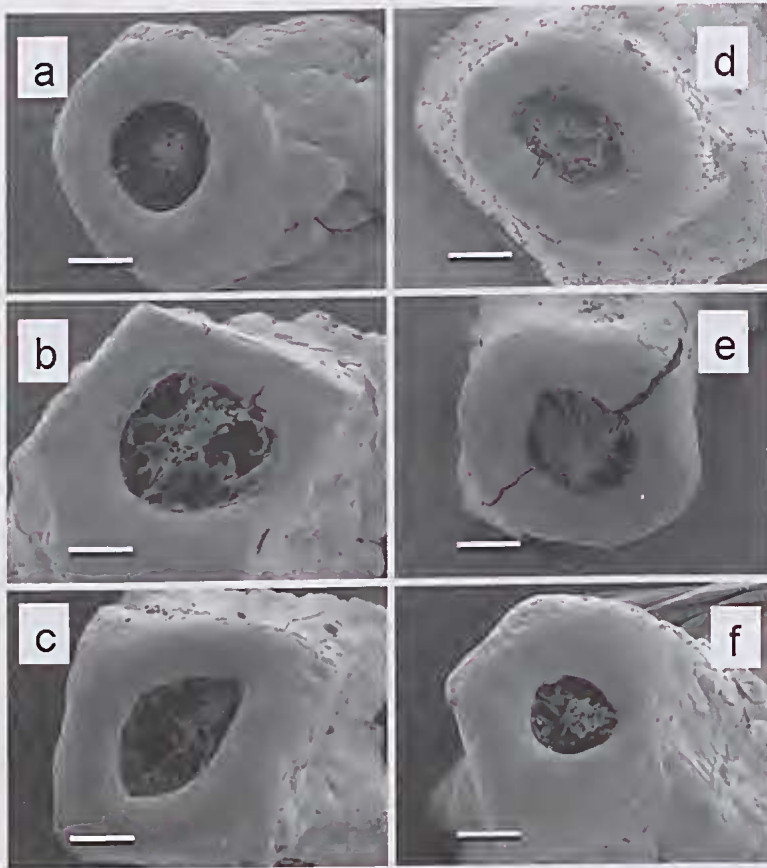


Figure 9: SEM images of carpopodia of (a) *L. albicans* subsp. *albicans* var. *tricolor*; (b) *L. albicans* subsp. *albicans* var. *albicans*; (c) *L. albicans* subsp. *olpinum*; (d) *L. albicans* subsp. *albicans* var. *buffoloensis*; (e) *L. grominifolium*; (f) *L. molle*.

Scale bars are 100 μ m.

Mt Buffalo NP, *P.S. Short* 1403 (MEL601904); Mt Buffalo, *S.T. Bloke* 7344 (BRI, MEL67470B); Mt Buffalo, *Chalet, R. Thomas* 76 (MEL1717322); Mt Buffalo, *C. & D. Woolcock* 1689 (MEL1524031); Mt Buffalo, iii.1931, *P.R.H. St John s.n.* (MEL2162059); Mt Buffalo, iii.1910, *W.R.A. Boker s.n.* (MEL2162060); Mt Buffalo NP, c. 200 m NE from Manfield Lookout, *N.G. Walsh* 5977 (MEL); Mt Howitt, 6.ii.1987, *E. Solkin s.n.* (MEL); Eildon-Jamieson Rd, 15 km from Jamieson, 7.xi.19B7, *E. Solkin s.n.* (MEL); Old Hume Hwy, Winton, *J. Strudwick* 676 (MEL)*.

***Leucochrysum albicans* var. *tricolor* (DC.) Paul G. Wilson, *Nuytsia* 8:443 (1992)**

Helipterum incanum var. *tricolor* DC., *Prodr.* 6:215 (1838).
Type: Van Diemen [Tasmania], *R.C. Gunn* 108 (holo: G-DC.), *vide* Wilson 1992.

A plant principally of grasslands and grassy woodlands on relatively fertile soils, often clays or

clay-loams derived from basalt or dolerite, or at higher altitudes, from sedimentary parent material. Altitude range c. 100–900 m a.s.l. NSW, ACT, Vic., Tas. (Fig. 10b)

Representative specimens (specimens marked with asterisk used for SEM studies): **NEW SOUTH WALES.** 2 km NW of Mt Majura, *I.R. Telford* 9890 (AD, CANB, MEL, PERTH); S of Tarago, 4.xi.19B4, *C.E. & D.T. Woolcock s.n.* (MEL); Between Blakney Ck and Bevendale, *E.M. Canning* 6384 (CANB, MEL, NSW, PERTH, S); Hill End, sources of Lachlan River, *J. Louterer* 2B (MEL); Wellington, Dubbo, Tomingley, collector unknown 4B, *s.d.* (MEL); Braidwood district, *W. Boeuerlen* 390 (MEL); Bombay Rd c. 500 m E of Shoalhaven R, *K.L. McDougall* 1204 (MEL); Kings Hwy, c. 1 km from Captains Flat turnoff, *K.L. McDougall* 1210 (MEL); Oallen Ford Rd, Windellama, *K.L. McDougall* 1213 (MEL); Snowy Mtn Hwy, 6 km E of Kosciuszko NP Boundary, *K.L. McDougall* 1220 (MEL). **VICTORIA.** Inverleigh Common, *E.G. Errey* 4861 (MEL); Narrapumelap, *A.C. Beoughlehole* 61646 (MEL); Skipton,

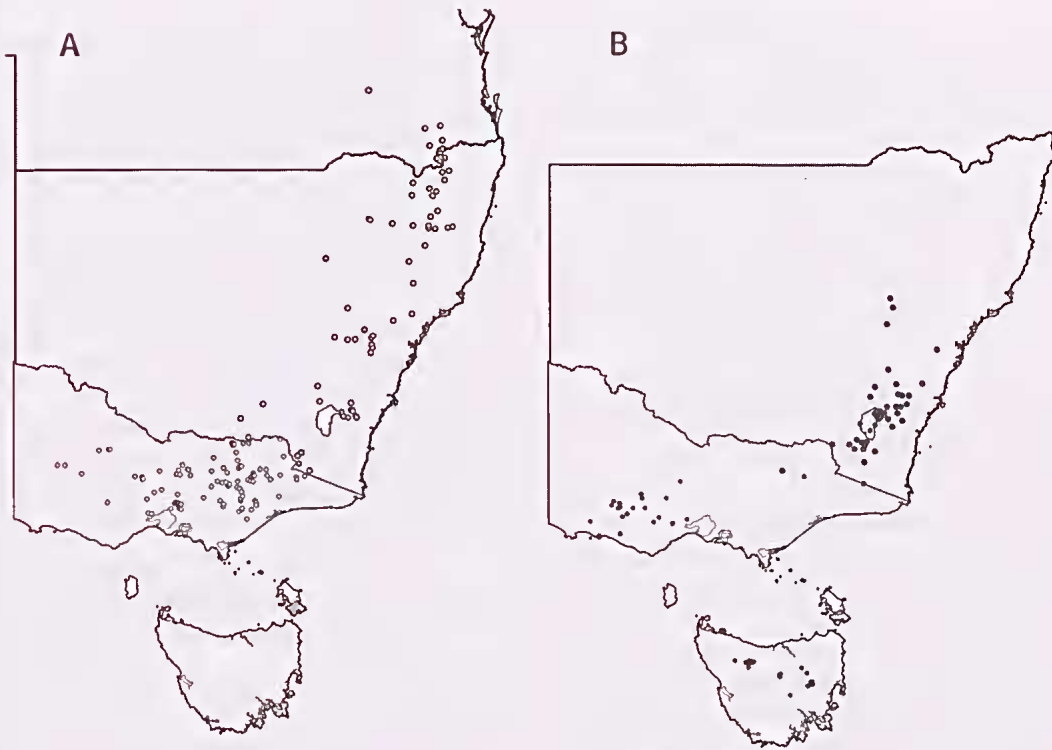


Figure 10. Distribution maps using geocode data records from MEL, AD, CANB and HO for the species (a) *L. albicans* var. *albicans*; (b) *L. albicans* var. *tricolor*.

W. Whan s.n., s.d. (MEL). **TASMANIA.** Circular Head Bluff, *J. Milligan 551* (MEL); ca 6 km SE of Ross, *M.J. Brown 45* (HO, MEL); Middlesex Plains, *R.C. Gunn 513* (MEL); Circular Head Bluff, *J. Milligan 551* (MEL); Circular Head, *E. Oakden 115* (MEL); 'van Diemens', *R.C. Gunn 155* (MEL); 'Tasmania', *G.F. Story 32* (MEL); Rokewood, *N.G. Walsh 6619* (MEL)*; Mt Buffalo NP, 0.3 km from McKinnons Corner, *J.A. Jeones 1653* (CANB, K, MEL, NSW)*.

***Leucochrysum alpinum* (F. Muell.) R.J.Dennis & N.G.Walsh comb. nov.**

Helipterum incanum var. *alpinum* F.Muell., *Rep. Pl. Babbage's Exped.* 14 (1859); *Leucochrysum albicans* subsp. *alpinum* (F.Muell.) Paul G.Wilson, *Nuytsia* 8:443 (1992). *Type:* Summit of the Australian Alps, *F. Mueller* (holo: MEL; iso: K, NSW).

Confined to treeless alpine and high subalpine heathlands and grasslands of the Australian Alps, usually on shallow soils derived from basalt, granite or sedimentary parent material. Altitude range c. 1500–2100 m a.s.l. NSW, Vic. (Fig. 10c)

Representative specimens (specimens marked with asterisk used for SEM studies): **NEW SOUTH WALES.** 20 km S of Picadilly Circus, *W. Bishop 580* (MEL292001, NSW, PRC); Between Seamans Hut and Mt Kosciuszko, *G. Stewort 751* (CANB, MEL1582200, PERTH); Scabby Range, c. 2 km SSW of Mt Kelly, *F.E. Davies 1712* (CANB, HO, MEL1662341, NSW, PERTH); Seamans Hut, *N.G. Walsh 3397* (MEL2013660) Kosciuszko National Park, above Club Lake, *P.S. Short 4004* (MEL201469B); 4 km SW from Charlottes Pass, *M. Ito 96041* (MEL2030392, NSW); Summit of Mt Clarke, xii.1903, *A.J. Tadgell s.n.* (MEL2162240); Mt Kosciuszko, *R. Helms 121403* (MEL2162242, NSW); Snowy Mountains, *W. Baeverlen 65* (MEL2162244); Mt Kosciuszko, *R. von Lendenfeld 12* (MEL2162246); Mt Kosciuszko, *J. Stirling 23* (MEL2162247); Munyang Mountains, i.1874, *F. Mueller s.n.* (MEL2162249); Happy Jacks Rd, 2 km from Snowy Mtn Hwy, 25.i.1987, *E. Salkin s.n.* (MEL2339316). **VICTORIA:** Mt Nelse summit, 11.ii.1977, *J.H. Willis s.n.* (MEL527153); Eskdale Spur, Mt Bogong, *L.A. Craven 2127* (CANB, MEL537943); Mt Nelse, 8.i.1954, *C. Skewes s.n.* (MEL599501); 1.2 km NE of Spion Kopje, 6.ii.1980, *R.J. Adoir s.n.* (MEL678310); Watchbed Ck, *A.C. Beoughlehole 15635* (MEL1505269); Mount Fainter, *A.C.*

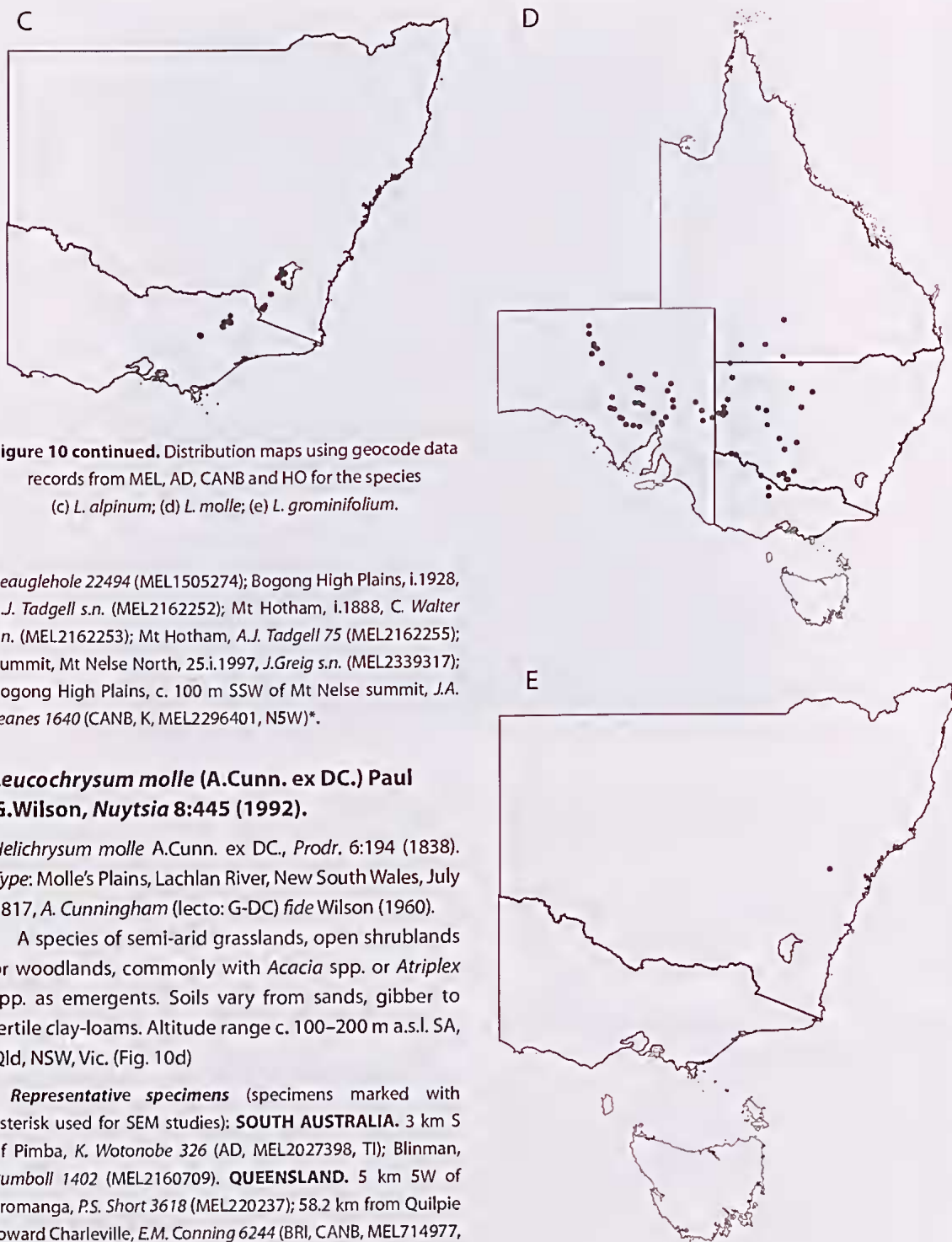


Figure 10 continued. Distribution maps using geocode data records from MEL, AD, CANB and HO for the species (c) *L. alpinum*; (d) *L. molle*; (e) *L. grominifolium*.

Beaglehole 22494 (MEL1505274); Bogong High Plains, i.1928, *A.J. Tadgell s.n.* (MEL2162252); Mt Hotham, i.1888, *C. Walter s.n.* (MEL2162253); Mt Hotham, *A.J. Tadgell 75* (MEL2162255); Summit, Mt Nelse North, 25.i.1997, *J.Greig s.n.* (MEL2339317); Bogong High Plains, c. 100 m SSW of Mt Nelse summit, *J.A. Jeanes 1640* (CANB, K, MEL2296401, N5W)*.

***Leucochrysum molle* (A.Cunn. ex DC.) Paul G.Wilson, *Nuytsia* 8:445 (1992).**

Helichrysum molle A.Cunn. ex DC., *Prodr.* 6:194 (1838).
 Type: Molle’s Plains, Lachlan River, New South Wales, July 1817, *A. Cunningham* (lecto: G-DC) *fide* Wilson (1960).

A species of semi-arid grasslands, open shrublands or woodlands, commonly with *Acacia* spp. or *Atriplex* spp. as emergents. Soils vary from sands, gibber to fertile clay-loams. Altitude range c. 100–200 m a.s.l. SA, Qld, NSW, Vic. (Fig. 10d)

Representative specimens (specimens marked with asterisk used for SEM studies): **SOUTH AUSTRALIA.** 3 km S of Pimba, *K. Wotonobe 326* (AD, MEL2027398, TI); Blinman, *Rumboll 1402* (MEL2160709). **QUEENSLAND.** 5 km SW of Eromanga, *P.S. Short 3618* (MEL220237); 58.2 km from Quilpie toward Charleville, *E.M. Conning 6244* (BRI, CANB, MEL714977, PERTH, S, US); E of Thargomindah, 1885, *G.L. Spencer s.n.* (MEL2160712). **NEW SOUTH WALES.** Steam Plains, c. 42 km NW of Jerilderie, *T. Jones 371* (MEL291999, NSW); Sturt NP, 5 of Olive Downs, *W. Greuter 18506* (MEL1543002); 2 km W of Cobar, *P.S. Short 3077* (MEL1556462); Tibooburra-Noccundra,

195.8 km from Tibaaburra, *E. Salkin* 762 (MEL2084703); Southern Barrier Range, 1893, *H. Deane* s.n. (MEL2160681); Warrega River, *E. Betche* 51 (MEL2160683); Evelyn Ck, N of Barrier Range, 1887, *A. King* s.n. (MEL2160685); Between the Bogan and the Darling, 1877, *W.L. Marton* s.n. (MEL2160686); Darling River, 14.x.1860, *H. Beckler* s.n. (MEL2160689); Between the Lachland and Darling river, x.1885, *J. Buckner* s.n. (MEL2160691); Lachlan River, *G. Tucker* 26 (MEL2160692); Silvertan, xi.1884, *Harris*, s.n. (MEL2160693); Lower Edwards River, *G.A. Mein* s.n., s.d. (MEL2160695); Wilcannia, 1885, *M.B. Kennedy* s.n. (MEL2160698); Byrock, *E. Betche* 7 (MEL2160699); Massgiel, 1885, *J. Brueckner* s.n. (MEL2160701); Barrier Range, 1889, *J.F. Irvine* s.n. (MEL2160702); 8ooligal, ix.1887, *A. Bell* s.n. (MEL2160706); Yandarlo via Wilcannia, *M.B. Kennedy* 27 (MEL2160708); Deniliquin, 21.ix.1968, *F.J.C. Ragers* s.n. (MEL2231783). **VICTORIA.** Kerang Mitiamo Rd, 22.xi.2005, *D. Marshall* s.n. (MEL2293160)*.

***Leucochrysum graminifolium* (Paul G.Wilson)
Paul G.Wilson, *Nuytsia* 8:444 (1992).**

Helipterum albicans var. *graminifolium* Paul G.Wilson, *Trans. Roy. Soc. South Australia* 83:171 (1960). Type: Clarence-Wolgan Rd, New South Wales, 26 Feb. 1939, *W.F. Blakely, J. & W.J. Buckingham* 3306 (holo: NSW; iso: AD, MEL).

A localised endemic growing on sandstone-ironstone outcrops (known locally as 'pagodas') in the Newnes-Capertee Valley area. Altitude range c. 800–1000 m a.s.l. NSW only. (Fig. 10e)

Representative specimens: NEW SOUTH WALES. Clarence-Walgalan Rd, 31.xii.1939, *W.F. Blakely, J. & W.J. Buckingham* s.n., (MEL, NSW); Wolgan Gap, 12.iv.1953, *L.A.S. Jahnsan* s.n. (NSW); Newnes Plateau, *J. Porter et al.* 20119 (MEL291446, NSW); Glawwarm Tunnel Rd, Wollemi National Park, *M. Kennedy et al.* 59 (NSW).

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